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PATENT SPECIFICATION

(11) 1 505 074

(21) Application No. 24614/74 (22) Filed 4 June 1974
(23) Complete Specification filed 30 May 1975
(44) Complete Specification published 22 March 1978
(51) INT CL^2 H01Q 21/08, 21/24//1/34
(52) Index at acceptance
H4A 1U3 3M 4A2S1 4A2S2 4V2A 4V3 6D 6G 8
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(19)

(54) IMPROVEMENTS RELATING TO RECEIVING AND/OR TRANSMITTING AERIAL SYSTEMS

(71) We, BRITISH AIRCRAFT CORPORATION LIMITED, a British Company, of 100 Pall Mall, London, S.W.1., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to receiving and/or transmitting aerial systems.

A receiving and/or transmitting serial system includes a first aerial array, a second aerial array, a structure on which the arrays are mounted at fixed angles in the elevation sense, and turntable means to which the structure is fixed for rotation in the aximuth sense, the first aerial array being composed of groups of aerials spaced apart in the elevation sense and having control means to apply variably phased signals to the said group such that its region of high radiation or high sensitivity is caused to sweep through a predetermined angle in the elevation sense, the second aerial array being positioned and so formed that in the elevation sense its region of high radiation or high sensitivity extends beyond the swept region associated with the first aerial array.

A preferred embodiment of the present invention is described with reference to the accompanying drawings.

In these drawings:—

Figure 1 is a diagrammatic side elevation of an aerial system,

Figure 2 is a plan view of the system of Figure 1,

Figure 3 is a view of an aerial array in the direction of Arrow III of Figure 1,

Figure 4 is a diagrammatic view of control apparatus associated with the array of Figure 3,

Figure 5 is a isometric view of a further aerial array in the general direction of Arrow V of Figure 1, and,

Figure 6 is a diagrammatic view of control apparatus associated with the array of Figure 5.

Referring initially to Figures 1 and 2, an aerial system includes a mounting structure 1 itself fixedly carried on a turntable 2. The turntable is capable of rotating through 360° about a vertical axis V—V in steps of 15°. It is driven by an electric motor, not shown.

The structure 1 has a planar face 3, which is set at 70° to the horizontal, and a further planar face 4, which is set at 5° to the horizontal. The face 3 forms a side wall and the face 4 forms a top of the structure 1. The structure is protected by a di-electric weather cover shown in broken outline for reference only at 5 in Figure 1.

The faces 3 and 4 each incorporate a planar array of aerials which are described with reference to Figures 3, 4 and 5, 6 respectively. That array incorporated on face 3 provides a region of high radiation (when in the transmitting mode) or a region of high sensitivity (when in the receiving mode) which is capable of being swept through an included angle of the order of 90° in elevation disposed equally about an axis normal to the face 3. Thus, because the face 3 is set at 70° to the horizontal, the included angle extends between 25° below the horizontal to 65° above the horizontal.

That array incorporated on face 4 provides a region of high radiation or high sensitivity which has an included angle of about 60° disposed equally about an axis normal to the face 4. Thus, because the face 4 is set at 5° to the horizontal, the included angle extends between 35° to the vertical on one side thereof and 25° to the vertical on the other side and consequently overlaps and extends beyond that swept region associated with the array on face 3 in the elevation sense. The effect is an aerial system covering an included angle in the elevation sense of about 140° extending from 25° below the horizontal, over the zenith, to 25° beyond the vertical.

Referring now to Figures 3 and 4, the aerial array on face 3 comprises twelve crossed dipole aerials disposed in four

horizontal rows of three, the rows being spaced in the elevation sense. Each crossed dipole, such as aerial 6, consists of four radiating elements 7, 8, 9 and 10, mounted on a dielectric sheet 11 which forms the face 3 of the structure 1. The individual elements of each aerial are fed from a phase splitter circuit 12. A phase splitter 12 is associated with each aerial but for reasons of clarity only one arrangement is shown. The phase splitter 12 is supplied via an input 13 with the signal to be transmitted and produces four output signals 14, 15, 16 and 17 which have phases of 0°, 90°, 180°, and 270°, respectively with respect to the input signal. The radiating elements 7, 8, 9 and 10 respectively are fed with these outputs so as to produce a circularly polarised transmitted signal.

The transmitted beam is swept through a 90° angle in elevation by a technique known as electronic steering, in which the phase difference between adjacent rows of aerials in the array is varied to determine the direction in which a wavefront of the transmitted beam travels. The row of aerials containing aerial 6 are fed from a phase shifter 18. Each of the other rows has its own phase shifter but only that shown at 18 is illustrated for clarity. All of the phase shifters are fed from common transmitter source 19. The phase difference introduced by each phase shifter is controlled by a computer 20 in such a way as to cause the transmitted beam to be steered by simply altering the phase relationships between the rows of aerials. For example, if the top row of the aerial array is used as the reference phase and the lower rows have progressively greater phase shifts, then a wavefront will be transmitted by the aerials at correspondingly later times so that the normal to the combined wavefront will not be perpendicular to the face of the array.

Referring now to Figure 5 and 6, the aerial array on face 4, the top of the structure, includes elongated elements 26, 27, 28 and 29, which are connected to the signal source, and slots 30, 31, 32, and 33 cut out of the face 4. The face 4 forms an upper wall of a rectangular chamber 25 and is made of conductive material. It is at ground potential. The beam radiated by this array is not steerable but is circularly polarised. The four elements 26, 27, 28 and 29 are fed with signals possessing phase increases of 90° progressively, in either anti-clockwise or clockwise directions depending upon the direction of polarisation. The elements are connected to a phase splitting circuit 34 mounted on a lower wall 35 of the chamber 25. The phase splitting circuit 34 is shown in Figure 6 and is simply a delay line of sandwich construction, comprising a conductive circuit mounted between two conductive sheets and separated from them by dielectric material. The input signal to the phase splitting circuits is connected to point C and the radiating elements 26, 27, 28 and 29 are respectively connected to the points H, J, K, and L, whilst the points E and F are connected to signal earth via 50 ohm impedance.

The described arrangement has particular use as part of a maritime satellite communications system where radio frequency signals are passed between, for example, a ship and a geostationary satellite. In its receiving mode the arrangement allows the satellite to be located and tracked, taking into account movements of the ship in pitch, roll and yaw. In the transmitting mode the arrangement also allows the transmitted beam to be directed towards the satellite. In both of these modes the elevation of the beam is controlled by electronic steering with the array on face 3 whilst angles near the zenith are covered by the array on face 4. The azimuth heading of the aerial system is controlled by the rotation of the turntable. The array on face 3 yields a beam of divergent form when viewed in plan so that small azimuth variations as for example between a satellite and a ship, can be tolerated before the turntable need be moved. Thus the turntable need not be continuously rotatable but instead may be driven by a stepping motor through a series of discrete positions where adjacent beam positions will overlap to give complete coverage.

WHAT WE CLAIM IS:—

1. A receiving and/or transmitting aerial system including a first aerial array, and a second aerial array, a structure on which the arrays are mounted at fixed angles in the elevation sense, and turntable means to which the structure is fixed for rotation in the azimuth sense, the first aerial array being composed of groups of aerials spaced apart in the elevation sense and having control means to apply variably phased signals to the said groups such that its region of high radiation or high sensitivity is caused to sweep through a predetermined angle in the elevation sense, the second aerial array being positioned and so formed that in the elevation sense its region of high radiation or high sensitivity extends beyond the swept region associated with the first aerial array.

2. An aerial system according to claim 1 wherein the first aerial array is of planar form with each aerial comprising two crossed dipoles having four elements in coplanar arrangement, the said groups being formed of horizontal lines of said crossed dipoles.

3. An aerial system according to claim 1 or claim 2 wherein the groups of the first array are fed from a common source

through phase shifting means associated with each group, each phase shifting means being controlled by computer means so that successive groups receive signals having progressively differing phase shifts.

4. An aerial system according to claim 3 when dependent upon claim 2 wherein each phase shifting means feeds a phase splitting circuit associated with each aerial of the first array, each phase splitting circuit supplying four separate signals, one for each element of each aerial.

5. An aerial system according to any one of claims 2, 3 or 4 in which the plane of the first array is set at an angle of the order of 70° to the horizontal and its region of high sensitivity or high radiation swept through an angle of the order of 90° in elevation disposed equally about an axis normal to the plane of the array.

6. An aerial system according to any one of the previous claims wherein the second aerial array has a planar face member set at an angle of the order of 5° to the horizontal and its region of high sensitivity or high radiation has an included angle of the order of 60° disposed equally about an axis normal to the plane of the face member.

7. An aerial system according to claim 6 wherein the second aerial array has its face member formed of a conducting material and forming an upper wall of a rectangular chamber, there being four slots formed in said face member adjacent the edges of said rectangular chamber and four elongated aerial elements lying within said slots.

8. An aerial system according to claim 7 in which the four elements of the second array are fed by phase splitting means, the signals passed to successive elements having phase increase of the order of 90°.

9. A receiving and/or transmitting aerial system substantially as described with reference to the accompanying figures.

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Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1978.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

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5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

Fig.1.

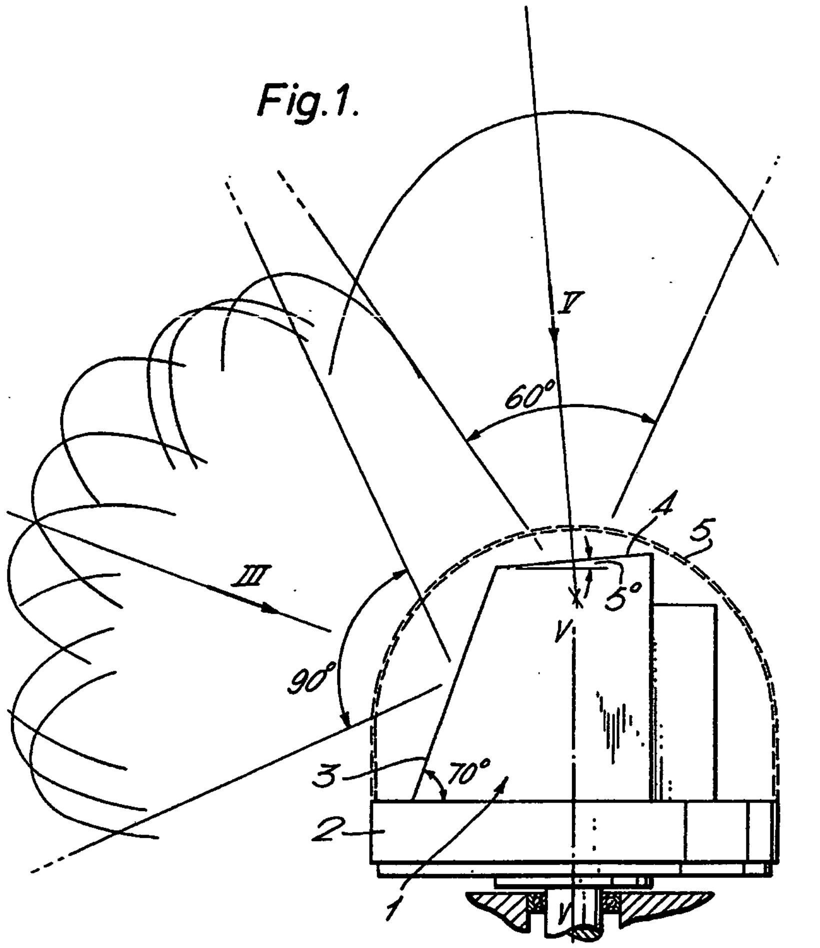

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Fig.2.

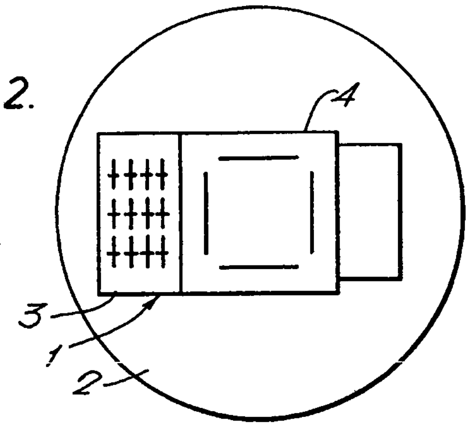

Fig.3.

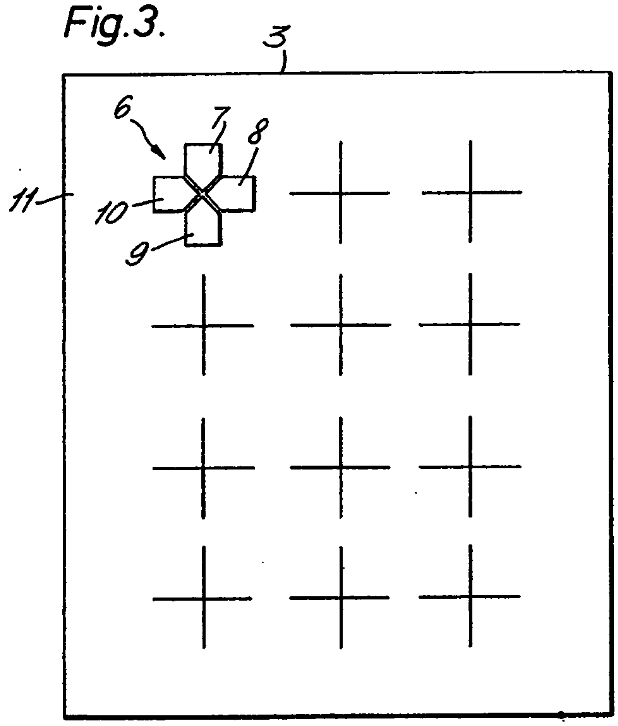

Fig.4.

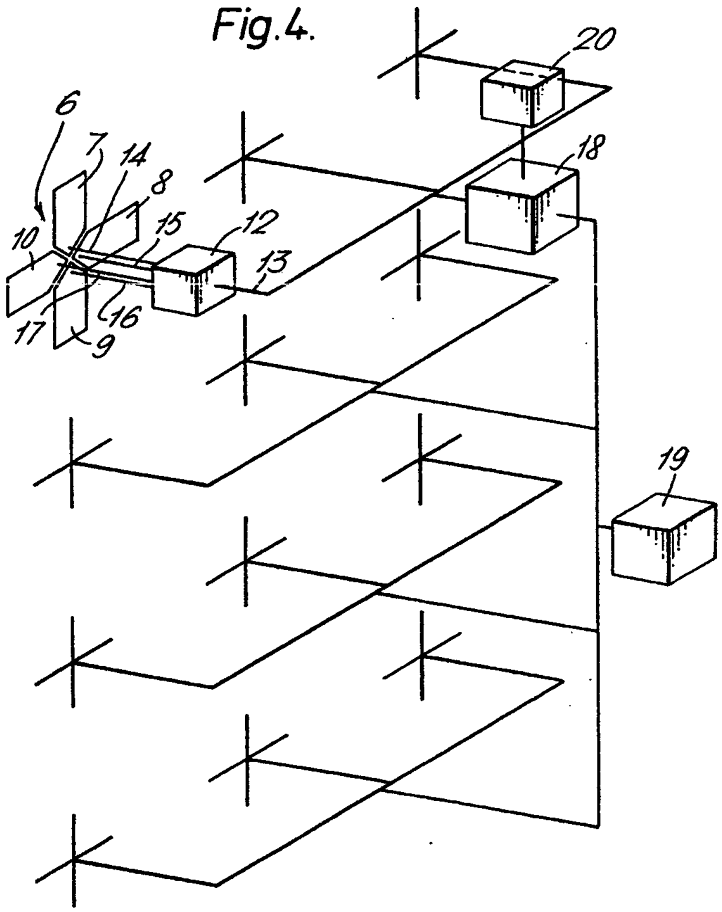

Fig.5.

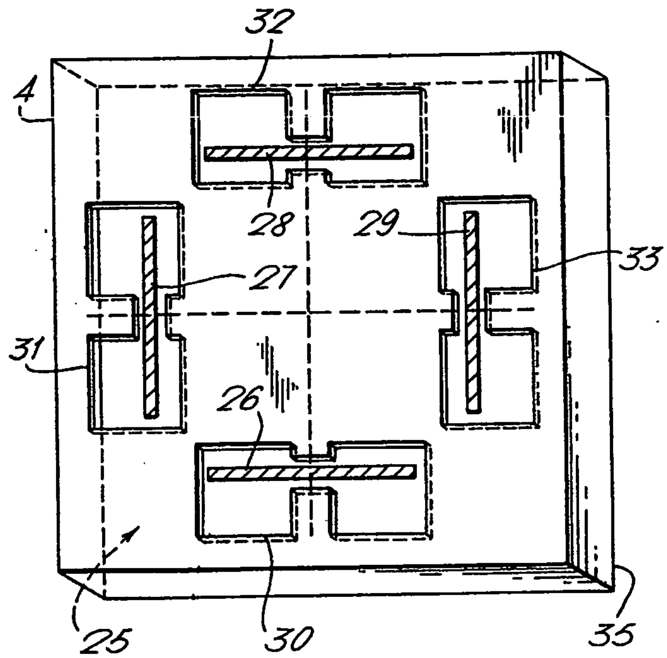

Fig. 6.